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Effects of Agricultural Practices and Socio-economic Characteristics on Biodiversity in Olamaboro Local Government Area of Kogi State, Nigeria

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Abstract

The study assessed the effects of agricultural practices on biodiversity in Olamaboro Local Government Are of Kogi State, Nigeria. One hundred and fifty (150) farmers (respondents) were sampled using simple random sampling technique from five council wards (30 farmers per council ward). Data collected were analyzed using descriptive statistics and Logit regression model. Results showed that 63% of the respondents were male, 56% were between 21-40 years, 61% were married, 46% were farmers, 58% acquired their land by inheritance with 24% having farming experience of 11-15 years and 37% owned a farm size between 1.01-2.0 hectares. Biodiversity was mostly lost through application of herbicides 36%, losses were more significant on species 48%, and use of agrochemical affected biodiversity most 43%. The results of Logit regression revealed that gender and land acquisition were some of the socio-economic characteristics that significantly affected biodiversity losses ($p<0.10$). It is recommended that agricultural practices with minimum disturbance to biodiversity should be practiced.

Keywords: Effects, agriculture, practices, biodiversity, Olamaboro

1. Introduction

The importance and value of biodiversity for human well-being is recognized globally, both in terms of its intrinsic and cultural value as well as the role it plays in providing essential ecosystem services. Indeed, amongst the public, there is widespread concern for the environment and biodiversity in particular, as expressed through environmental NGOs and pressure groups (Poláková *et al*., 2011). Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Biodiversity, therefore, is understood as relating not just to species, but also to genetic diversity, habitats and ecosystems, Convention on Biological Diversity (CBD, 1992).

Agriculture has been practiced in Nigeria for centuries, modifying the natural environment to the extent that there is little remaining natural habitat. These trends do not just impact upon biodiversity on farmland. By impacting on the provision of other ecosystem services, such as water quality or air quality, biodiversity in the wider environment is also affected. Most natural agricultural habitats, and virtually all natural forests, have now been lost as a result of these activities, as well as forest clearance and the conversion of grasslands to croplands (for cultivated and permanent crops).

It is clear from numerous studies, including Winspear *et al*. (2010); Poláková *et al*. (2011); CBD (2008); Winqvist *et al*. (2011) that these changes have had major impacts on biodiversity. This is because the key determinant of the richness and abundance of biodiversity associated with agricultural habitats is the degree to which they have

been modified from their natural state (example, as a result of grazing, one-off or occasional agricultural improvements, ploughing and conversion from grasslands to crops) and the intensification or modernization of management (example, cultivations, the use of fertilizers, irrigation and pesticides) and specialization in particular intensive systems. Consequently, most of the higher yielding and economically attractive farming systems and their associated agricultural practices are hostile to many species and often no longer provide sufficient food resources for wild species that would otherwise tolerate the conditions (Winspear *et al*., 2010; Poláková *et al*., 2011).

The headline target of halting the loss of biodiversity and the degradation of ecosystem services in many countries by 2020 and restoring them is not feasible. Furthermore, it is important to note that biodiversity conservation does not just focus on rare and threatened species and habitats listed in the birds and habitats directives. The maintenance of populations of widespread and common species, including those of agriculture habitats is also a serious concern. Although some progress has been made towards halting biodiversity loss in many countries including Nigeria, the status of most species and habitats still gives rise to concern (EEA, 2009). Biodiversity, therefore remains a political priority and the importance of protecting and enhancing biodiversity is formally recognized through high level agreements and targets, including those of the Convention on Biodiversity (CBD) (to which many countries are signatory) and the Nigeria's own targets. Having failed to meet the 2010 target, a new and more demanding headline target has been set 'to halt the loss of biodiversity and the degradation of ecosystem services in the by 2020' (Poláková *et al*., 2011).

Conventional insecticides generally reduce diversity through direct toxic effects. Many of the widely used classes of conventional insecticides, including organophosphates and pyrethroids have been shown to adversely affect a broad range of non-target species, including species of economic importance. Local extinctions are common where these insecticides are frequently used. Such insecticides have been shown to eliminate important predator and parasitoid species from agricultural systems (Pimentel *et al.,* 1993).

The effect of tillage on biodiversity in agricultural fields is the disruption of in-field communities and reduction of soil quality being the most obvious. However, the effects of tillage on natural habitats are even greater. Soil erosion due to tillage leads to high levels of fertilizers and pesticides being carried off agricultural fields into water ways. The past three decades have witness 6.87-fold increase in nitrogen fertilization and a 3.48-fold increase in phosphorus fertilization within intensive agricultural systems (Tilman, 1999; Tilman *et al*., 2002).

As the chemicals move into aquatic systems, these chemicals can have direct toxic effects on natural communities, while the fertilizers cause eutrophication. Eutrophication leads to direct losses in biodiversity, pest outbreaks, and changes in the structure of natural communities. In addition, because erosion leads to various forms of nitrogen and fertilizer dust being redistributed aerially, natural terrestrial ecosystems also is being eutrophicated. (Hayati and Proctor, 1991; Woo and Zedler, 2002). Habitat loss and fragmentation represent the greatest threats to natural genetic diversity. Practices that increase the productivity of existing agricultural lands will help to limit these effects (UNDP, 2001).

The changes in environment associated with agriculture affect a wide range of ecosystem services including food and materials for human consumption, water quality and quantity, soil quality, air quality, carbon sequestration, pollination services, seed dispersal, pest mitigation, biodiversity, habitat change and habitat degradation, and protection from disturbances (Pimentel *et al*., 1993).

Loss of biodiversity is occurring in many parts of the globe at a rapid pace. It can be measured by loss of individual species, groups of species or decreases in numbers of individual organisms. In a given location, the loss often reflects the degradation or destruction of a whole ecosystem. According to the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA, 2003), habitat loss is the greatest, most serious of all threats to biodiversity. Habitat loss due to the expansion of human activities, including urbanization and the increase in cultivated land surface is identified as a main threat to 85% of all species described in the IUCN red list (IUCN, 2000).

Many pesticides are toxic to beneficial insects, birds, mammals, amphibians, or fish. Water soluble pesticides may pollute surface water, the quantity applied, frequency, timing and method of spraying, (fine spray is prone to drift), weather, vegetation structure, and soil type. Insecticides, rodenticides, fungicides (for seed treatment) and toxic herbicides threaten wildlife. Over the past 40 years, the use of highly toxic carbonate and organophosphate has strongly increased. Organ chlorines such as endosulfan, highly persistent in the environment, are still used on a large scale. With habitat change, pesticide poisoning can cause major population decline which may threaten rare species.

Agricultural pesticides can reduce the abundance of weeds and insects which are important food sources for many species. Herbicides can change habitats by altering vegetation structure, ultimately leading to population decline. Pesticides accumulating in the food chain, particularly those which cause endocrine disruption, pose a long-term risk to mammals, birds, amphibians, and fish. Broad-spectrum insecticides and herbicides reduce food sources for birds and mammals. This can produce a substantial decline in rare species populations. By changing vegetation structure, herbicides can render habitats unsuitable for certain species.

2. Materials and methods

Olamaboro is one of the 21 Local Government Areas (LGAs) in Kogi State, Nigeria. The LGA was created out of Ankpa LGA in 1989. The LGA is made up of three districts namely; Imane, Okpo and Ogugu with a population of 116,692 (NPC, 2006). It is located at the South east of Kogi State, bordering Enugu State and Benue State. Its headquarters is at Okpo. It is about 80km from Okpo to the state capital. Kogi State shares common boundaries with Niger and Nasarawa States and the Federal Capital Territory to the North and Benue State to the East. To the West, it is bounded by Kwara, Ekiti and Ondo States and to the South by Enugu, Anambra, and Edo States.

Olamaboro LGA lies between latitude 10^0 N and Longitude 12^0 E. There are three major ethnic groups in the LGA namely; Igala, Ebira and Yoruba. The type of soil is alluvium soil. Two distinct seasons are experienced in the area, dry season last from November to February and rainy season that last from March to October. The climate favours the cultivation of wide range of food crops including: tree crops, roots crops, and grain crops such as yam, oil palm, cashew, cassava, cocoyam, maize, vegetables but the soil do not favours rice production. The major cash crops produce in the area are oil palm and cashew. The major root crops produce in the area are yam and cassava while grains include maize, sorghum, cowpea, and millet. The inhabitants of the area also engage in basket weaving as well as poultry rearing (Edoka, 2006).

The population for the study was all rural farmers in Olamaboro Local Government Area. Due to the enormity of the population 150 farmers (respondents) were selected using random sampling technique; Olamaboro Local Government comprises ten council wards. Five Council wards were selected purposively namely: Adeh, Okpo, Igalkeje, Iyele and Etutekpe. Thirty (30) respondents were selected from each of the five council wards chosen given a total of one hundred and fifty (150) respondents.

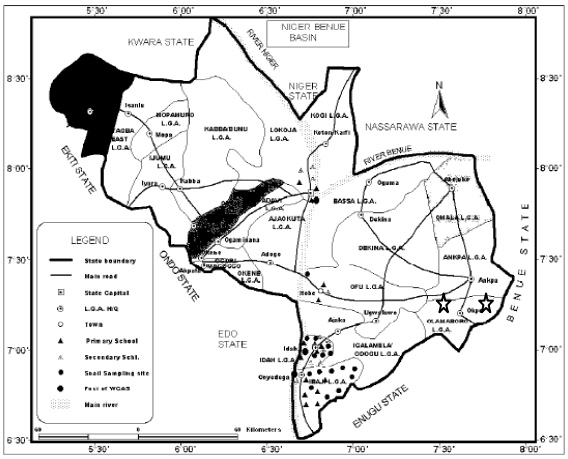

Figure 1. Map of Kogi State indicating the study area with stars

Data were collected from primary source. Primary data were collected through the use of structured questionnaire administered on the respondents. Data collected were analyzed using descriptive statistics and Logit Regression Model. The determinants of frequency of agricultural practices used in the study area were estimated using logit regression model showing socio- economic characteristics influencing rate of biodiversity depletion, the model is expressed as:

$$\mathbf{P_i} = \frac{\mathbf{1}}{\mathbf{1} + \mathbf{e}^{-(\beta_o + \beta_1 x_{i1} + \ldots + \beta_k x_{ik})}}$$

Where,

$\mathbf{P}i$ =Probability that socio-economic characteristics influencing rate of biodiversity depletion

β_o =Constant term

β_k =Coefficient to be estimated

X_k =for K=1……..8 which are independent variables

i=i^{th} observation.

Let $Z_i = \beta_o + \sum \beta_k X_{ik}$

Then $Pi = \frac{1}{1 + e^{-Z}}$

As Z_i ranges from –α to + α, P_i ranges from 0 to 1 and $\mathbf{P}i$ is non-linearly related to Zi. The Logit of the unknown binomial probabilities that is, the Logarithms of the odds, are modelled as a linear function of the X_i. In estimable form, the model is expressed as,

$$\log it(P_i) = \ln\left(\frac{p_i}{1-p_i}\right) = \beta_o + \beta_1 X_{i1} + \ldots + \beta_k X_{ik} + U_i$$

The unknown parameters β_i are usually estimated by Maximum likelihood. Thus, the model is explicitly expressed as

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \uparrow U_i$$

Z_i = Socio- economic characteristics influencing rate of biodiversity depletion;
β_o = Constant term; β_i = (1-8) vector of the parameter to be estimated;
X_1=age of respondents (number in years)
X_2=Gender (dummy: male 1, female 0)
X_3=marital status (dummy: if married 1 and otherwise 0)
X_4=Farm size (in hectares) 1, 2, 3, etc
X_5 =Farming experience (number in years) 1, 2, 3, etc
X_6 =Annual income Naira (₦) 1, 2, 3, etc
X_7=Major occupation (dummy: farming 1 otherwise 0)
X_8=Land acquisition (dummy: inheritance 1, otherwise 0)

3. Results and discussion

Age

Results in Table 1 indicate the ages of the respondents 20-40 years, 56.6%; 41-60, 30.7%; less than 20, 4% and above, 61 8.7% with a mean of 38.87. Majority (56.6%) were between 20-40 years old. The age group of between 20-40 years are adults who are very active people. Agricultural activities carried out by farmers which cause biodiversity losses are usually done by people who are very active in the practice of agriculture. In the rural area, most of the young able-bodied men are involve in farming as a business or for family consumption which directly or indirectly deplete biodiversity.

Gender

Results in Table 1 show Gender of the respondents: male 63.3% and female 36.6% with a mean of 3.12. Majority (63.3%) were male. Males are generally more involved in practices that led to biodiversity losses including hunting of wild animals, farming and application of herbicides among others. This means that male were more involved in carrying out activities which causes biodiversity losses. People in the rural areas get involved in different activities for many reasons: the hunters hunt to get meat for domestic consumption which serve them as a source of protein and for commercial purposes including income. The application of herbicides clears the grasses to allow farmers to cultivate their crops among others.

Marital Status

Results in Table 1 depict the marital status of the respondents married 61.3%, single 26.0%, widow 6.1% divorce 5.3% and separated 1.3%. A high (61.3%) proportion of the respondents were married. This is an indication that married people would be more involved in activities which led to biodiversity losses including agriculture for food production and as a source of income generation to take of their families. The rural populace consider agriculture either as a hobby or a profession. For people who view farming as a hobby; their actions (agricultural practices that leads to biodiversity losses) is seen as doing what they enjoy best without noticing that their activities are detrimental to living organisms. For farmers, some of them are aware of the effects of agricultural practices on the environment. However, agriculture been their main source of livelihood, they do not look at the long time effects of their actions but considers only the immediate benefits of producing crops for their personal use.

Farm size (ha)

Results in Table 1 indicate the frequencies and percentage of the respondents farm size that less than 1.01-2.00ha, 37.3%; 2.01-3.00ha, 15.3%; 3.01ha, 24.7%; at least 1, 22.7% with a mean of 2.50. A reasonable (37.3%) proportion of the respondents had 1.01-2ha of farmland and above. This implies that the respondents had small farmland. Farm size determines how frequent or not the farm is put use. The larger the farm size the less the farmland is use, however the smaller the farm size the more the farmland is put use. In African culture, parents' farmland is shared among members of the family which leads to fragmentation of the farmland into smaller pieces based on family portions, making mechanization of agricultural practices very difficult. When farmlands are fragmented among family members, the smaller portions are more frequently used causing more destruction to biodiversity.

Farming experience

Results in Table 1 show the farming experience in years that 11-15, 24%; 6-10, 21.3%; at least 5, 9.4% and more than 16 years, 45.3%. A small (24%) proportion of respondents had farming experience of 11-15years. This is an indication that, most of the respondents were not experienced farmers. Farming experience is very important among farmers as it helps in ascertaining time to plant certain crops, best cultural practices to be adopted for high yield, the most appropriate time to start harvesting crops, the best methods for storing farm produce among others.

Annual income

Results in Table 1 indicate that 19.35% of farmers had less than 50,000 Naira. Most farmers in Nigeria are peasant, who use crude farm implement

for cultivation, this limit their annual income to at most 500,000.00 Naira per annum.

Major occupation

Results in Table 1 indicate the major occupation that farming, 46.7%; civil service, 31.3%; petty trading, 14.7%; others (fishermen and rearing of animals) 4% and artisan, 3.3%. Reasonable (46.7%) proportions were farmers. This is an indication that most people in the area were farmers. Even those who are in the civil service practice farming on part time basis. Farming is one of the major causes of biodiversity losses; a lot of farming activities directly or indirectly deplete biodiversity. For instance, the application of agrochemicals to reduce field pests, diseases, weeds and increase yield, the use of farm machinery, the application of chemicals to prevent store pests and diseases from spoilage are some of the major causes of biodiversity losses.

Land acquisition

Results in Table 1indicate land acquisition that inheritance, 58.7%; purchase, 16%; gift, 14.6% and lease, 10.7% with a mean of 9.90. Majority (58.7%) acquired their land through inheritance. This is an indication that most of the respondents are indigenes of the study area who obtained their land through their forth fathers. This is an indication that land is highly fragmented in the area. In most parts of rural Nigeria, land is acquired through inheritance a practice of acquiring land through inheritance has cause several communal clashes. In some cases, claims and counter claims of ownership of land within or between communities often result to communal cries. Results in Table 2 show causes of biodiversity losses through application of herbicides, 36.7%; urbanization, 23.3%; farming, 15.3%; hunting, 14.7% and environmental design, 10%. A reasonable (36.7%) proportion biodiversity was lost through the application of herbicides.

The application of herbicides by farmers in the rural area is one of the major causes of biodiversity losses. Farmers in their quest to increase the quantity and quality of output apply different agrochemicals either to eliminate pest and diseases, nematodes, fungicides among others. Furthermore, herbicides are the most frequent use agrochemical by farmers for clearing of grasses before tillage, during pre-emergence and during post-emergence for crop production.

The application of herbicides in our environment is very high not only for farm purposes. Herbicides are also use for clearing both domestic and industrial areas. The applied herbicides are washed into water bodies; which contaminates water consumed by different organisms and humans. In some instances, agrochemicals are directly use for killing of fish by people to facilitate quick harvesting of fish in the streams by the villagers. The contaminated water leads to biodiversity losses. This confirms Kughur (2012) who reported that there is lack of effective disposal methods of herbicides, widespread use of empty containers and lack of quantification and documentation of wastes, poor storage conditions for obsolete stocks, especially in developing countries.

The finding also corroborates Fit and Wilson (2003) who reported that modern agricultural practices including tillage and intensive use of insecticides have been broadly linked to decline in biodiversity in the ecosystem. The practice of putting land to agricultural use limits gene flow among population and fragment habitats available to any particular species. The finding agrees with Pimentel *et al.* (1993) who reported that the use of conventional insecticides have been shown to eliminate important predators and parasitoid species from agricultural systems.

Results in Table 3 reveal that there were many effects of farming practices on biodiversity: loss of species, 48.0%; reduction in soil organic matter, 26.7%; degradation of water quality, 16.0% and emission of carbon to the environment 9.3%. A reasonable proportion (48%) effect of farming practices on biodiversity is lost of species. Farming practices like tillage, application of agrochemicals (herbicides, insecticides, fungicides, etc.), use of farm machinery, farming also leads to deforestation; all leads to loss of species.

Green revolution which introduced the application of high agricultural inputs to mass produce crops on small piece of land to feed the growing population contributed significantly to biodiversity losses. When agrochemicals are applied to the soil, both the beneficial and non-beneficial living organisms are killed, the killing of beneficial living organisms could reduce the nutrients recycling process thereby reducing the available nutrients in the soil.

Deforestation destroys organisms' habitat and sometimes subsequent killing of some organisms; the planting of crops in such areas further drives away many living organisms (different species of wildlife).

This confirms Wood *et al*. (2000) who reported that intensive tillage tends to reduce soil organic matter levels by causing oxidation of organic matter. The finding contradicts Smith *et al.* (2008) who stated that mechanical tillage tools release carbondioxde through the combustion of fossil fuels and tillage itself stimulates carbon dioxide emission by enhancing decomposition of soil organic matter.

Table 1. Socio-Economic Characteristics of Respondents

Characteristics	Frequency	Percentage
Age (years)		
21-40	85	56.6
41-60	46	30.7
> 61	13	8.7
< 20	6	4.0
Total	150	100
Gender		
Male	95	63.3
Female	55	36.7
Total	150	100
Marital status		
Married	92	61.3
Single	39	26.1
Widowed	9	6.1
Divorced	8	5.3
Separated	2	1.3
Total	150	100
Farm size (hectares)		
1.01- 2.00	56	37.3
3.01 and above	37	24.7
Less than 1	34	22.7
2.01 – 3.00	23	15.3
Total	150	100
Farming Experience (Years)		
16 and above	68	45.3
11-15	36	24.0
6 – 10	32	24.0
Less than 5	14	9.4
Total	150	100
Annual income (Naira)		
Less than 50,000	29	19.3
50,001-100000	50	33.3
100,001-150,000	14	9.4
150,001and above	57	38.0
Total	150	100
Major occupation		
Farming	70	46.7
Civil service	47	31.3
Petty trading	22	14.7
Others (fishermen & livestock rearing)	6	4.0
Artisan	5	3.3
Total	150	100
Land acquisition		
Inheritance	88	58.7
Purchase	24	16.7
Gift	21	14.6
Lease	16	10.7
Total	150	100

Table 2. Distribution of Respondents by Causes of Biodiversity Losses

Causes of biodiversity losses	Frequency	Percentage
Application of herbicides	55	36.7
Urbanization	35	23.3
Farming	23	15.3
Hunting	22	14.7
Environmental design	15	10.0
Total	150	100

Table 3. Distribution of Respondents Based on Effects of Farming Practices on Biodiversity

Effects of farming practices on biodiversity	Frequency	Percentages
Loss of species	72	48.0
Reduction in soil organic matter	40	26.7
Degradation of water quality	24	16.0
Emission of carbondioxde to the environment	14	9.3
Total	150	100

Table 4. Distribution of Respondents According to Farming Practices that Affect Biodiversity

Farming practices that affects biodiversity	Frequency	Percentage
Use of agrochemicals	64	43.0
Use of farm machinery	31	20.8
Intensive grazing	26	17.4
Intensive tillage practices	18	11.4
Monocropping	11	7.4
Total	150	100

Table 5. Binary Logit Regression Analysis Showing Socio-economic Characteristics Influencing Rate of Biodiversity Depletion

Independent variable	B	Wald	Significance
Age	0.24	1.690	.194
Gender	0.732	3.118*	0.077
Marital status	0.256	0.403	0.525
Farm size	-1.00	0.495	0.482
Farming experience	0.001	0.001	0.975
Annual income	0.000	2.208	0.137
Major occupation	-0.387	0.987	0.321
Land acquisition	-1.351	9.884***	0.002
Constant	0.208	0.47	0.829
Chi-square	19.456		
Pro>x^2	0.022		
Nagelkerke R. square	0.165		
Hosmer and Lemeshow	7.033	0.533	

*, *** Wald test of significance at 10% and 1% level respectively.

Results in Table 4 show farming practices that affect biodiversity, use of agrochemicals, 43.0%; use of farm machinery, 20.8%; intensive grazing, 17.4%; intensive tillage practices, 11.4% and monocropping, 7.4%. A reasonable proportion (43%) use of agrochemicals affects biodiversity. Application of agrochemicals kills both targeted and non-targeted insects. The non-targeted/beneficial insects when eliminated by agrochemicals create more room for abundance of non-beneficial insects. Farmers' use of agrochemicals is on the increase. Some agrochemicals applied on farm may be beneficial in terms crop yield but detrimental in the area of depletion of biodiversity. The finding contradicts Oerke and Dehne (1997) who reported that without application of agrochemicals, it has been estimated that the losses would increase to 70%, with an economic loss of $400 billion USD per year.

Chi-square significance at 5% is related to biodiversity depletion. Non significance of Hosmer and Lemeshow indicates that the model is not significance different from the standard model. Gender and land acquisition were significant on depletion of biodiversity at 5% level, this implies that the socio-economic characteristics included in the model are significantly related to the rate of biodiversity depletion. This result rejects the null hypothesis that socio-economic characteristics does not significantly influenced rate of biodiversity depletion in the study area.

The results further shows that the coefficients of gender (1, 0) and land acquisition (1, 0) influenced rate of biodiversity depletion significantly, the coefficient of gender was positive and significant at 10%. This implies that increase in male participation in farming increases the probability of high rate of biodiversity depletion than the female farmers.

The results also show that the coefficient of land acquisition (1, 0) significantly influenced rate of biodiversity depletion. This implies that those that

acquired their land through purchase, lease are the ones that deplete the land most because they frequently use the land thereby causing depletion leading to biodiversity losses. People who acquired land through purchase may not any other piece of land where therefore, make use of the land more often than those who have other pieces of land.

4. Conclusion and recommendations

The geometric increase in population has led to application of agricultural practices that are detrimental to environment in order to produce food to feed the growing population, some of the practices such as herbicide and pesticide use, drainage and irrigation, the use of artificial fertilizers and monocropping to mention but just a few have negative effects on the biodiversity. The depletion of biodiversity is harmful to agriculture and human beings, this trend if not checked properly will lead to a catastrophe. Therefore, conservation measures need to be taken to avoid or reduce the impacts of these practices below critical thresholds. It is recommended that agricultural practices with minimum disturbance to biodiversity like zero tillage, organic agriculture, application of pesticides only when it necessary among others should be practiced**.**

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